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ABSTRACT

The potential benefits of satellite communications development have been recognized since the notion of a geostationary "space platform" was proposed by Arthur C. Clarke in 1945. Although there have been examples of developmental applications of satellite technology, the promise has been slow in being fulfilled. The history of the application of this technology for developmental purposes falls into three phases: from Clarke's 1945 proposal until about 1970 may be considered the "conjectural" era; from approximately 1971 until 1977 may be considered the "experimental" era; and the present may be called the "operational" era, as satellite services for developmental purposes are beginning to be offered on commercial satellites. Although this classification suggests a progression, progress, in fact, has been sporadic. To understand why the promise of communication satellites seems to have been delayed, if not denied, a number of factors must be considered: application, the development sector, economics, the telecommunications sector, organization, and politics. By the end of the decade, communications researchers will be better able to determine whether or not the developmental potential of communication satellites has been realized or indeed if it can be realized. In the meantime, researchers can assist planners in applying the lessons learned both from experiences with satellite research to date and from the introduction of other communications innovations. (HTH)

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Satellite Communication and Development: A Reassessment

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Satellite Communications and Development: A Reassessment

1. Introduction

The potential benefits of satellite communications for development have long been recognized since the notion of a geostationary "space platform" was proposed by Arthur C. Clarke in 1945. Yet, although there have been examples of developmental applications of satellite technology, the promise has been slow in being fulfilled. This paper examines the reasons for the lag in developmental applications and benefits, and proposes an analytical framework for planners and researchers concerned with the applications of the technology for development.

We may consider the history of the application of satellite technology for developmental purposes in three phases. The first, from Arthur Clarke's proposal in 1945 until about 1970 may be called "The Conjectural Era." The second phase, from approximately 1971 until 1977, may be considered "The Experimental Era." We are now in what may be considered "The Operational Era," when satellite services for developmental purposes are beginning to be offered on commercial satellites.

The selection of these dates is based not on the history of the technology (e.g. launch dates), nor on the beginning of commercial services, but on the history of communication satellite applications for developmental purposes. Developmental applications will be defined for the purposes of this paper as uses of satellite technology for education, health care and other social services, agricultural and rural development, and cultural enrichment. This definition excludes international satellite communications and domestic commercial broadcasting services. It includes applications of thin route telephony, teleconferencing, and educational/public radio and television.

2. The Three Eras

The "Conjectural Era" may be said to begin with Arthur Clarke's own vision of the potential benefits of satellites. Clarke saw a major function of satellites as the transmission of broadcast signals over great distances, in particular across large continents (as opposed to small countries like Great Britain) and across the oceans. The existence of the INTELSAT system and the numerous U.S. domsats are testimony to his foresight.

However, Clarke misjudged the institutional environment into which his proposed "space platforms" would be introduced, a theme which has been repeated several times during satellites' brief history. Although technically correct that satellite transmission was inherently less expensive than construction of terrestrial repeater systems for broadcasting, Clarke did not foresee the tremendous demand for television which made the high capital investment in transmission systems justifiable in Europe and North America. However, he did accurately forecast the environment in most developing regions. (Clarke, 1945)

In the 1960's, satellite technology caught the fancy of educators who were captivated by the potential of the technology as the ultimate "magic multiplier," able to transmit television to receiving sites throughout a nation or continent. Again, they overlooked the environment into which the technology would be introduced -- an environment which seemed to offer little incentive for this particular application of the technology.

Neither did the educators and communicators pay much attention to the interactive capabilities of satellites, namely for telephone services, data transmission, and teleconferencing. Here, again, the forecasters were limited by their own environment, but in this case an intellectual environment in which broadcasting was touted as an important developmental medium for disseminating information, and the telephone was totally ignored as a

development tool. Obviously, data communications and teleconferencing were much less common than they are today, but prototypes such as two-way high frequency radio networks for simple teleconferencing and telex networks for basic data transmission were certainly well established, and their benefits well understood by their practitioners.

Although satellites went into international commercial service in the mid-1960's, for our purposes the conjectural era can be said to extend until the early 1970's, because the initial services were for international point-to-point services between major centers, primarily in industrialized countries.

"The Experimental Era" may be considered to extend from 1971 to 1977. During this period, there were numerous experiments and demonstrations of satellite applications for education and training, health services, community development, and cultural exchanges. These projects were conducted on NASA's Applied Technology Satellite Series (primarily ATS-1 and ATS 6, and to a lesser extent ATS-3), and the joint U.S.-Canadian Communications Technology Satellite (CTS or Hermes). These experiments took place primarily in the U.S. and Canada, but also included the Indian Satellite Television Instructional Experiment (SITE) which used the ATS-6 in India in 1975.*

It is not the purpose of this paper to review in detail the experiments and demonstrations of the 1970's. They were analyzed in evaluations which were required of all the U.S. and Canadian projects, and summarized in several reports and articles (see for example, the Journal of Communications, Autumn 1979) and the Royal Society of Canada's Symposium of CTS (Hermes, 1977). The lessons from this period will be outlined below.

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*Demonstrations of telecommunications and television transmissions via satellite were also carried out in Africa and Asia on the French-German experimental Symphonie satellites during this period.

"The Operational Era" may be said to have commenced in the latter 1970's. The late 1970's and the early 1980's can be characterized by several developments which have pushed satellite applications out of the realm of experiments and demonstrations, and into the early phases of operational services. These developments include:

-- the installation in Alaskan villages of more than 100 small earth stations for telephony and later broadcasting, (this project began in 1976, but took more than two years to be completed);

-- the use of INTELSAT satellites for domestic communications by many developing countries (at least 20 countries by early 1983);

-- the launching of the first domestic satellite owned by a developing country (Indonesia, in 1976), and the plans by several other developing countries to procure domestic or regional systems, at present, including Indonesia's regional PALAPA B, ARABSAT, and systems for India (INSAT), Mexico (ILHUICAHUA), Brazil, and China,

-- the recognition by ongoing "experimenters" e.g. in Canada and the South Pacific, that they needed to take steps to make a transition to operational services.*

3. Few Successes

This classification into three eras appears to suggest that there has been a progression from conceptualization through experimentation to operation of satellite services for development. In fact, progress has been sporadic and in many cases, the activity has stopped or become stalled at one phase, or a user has plunged headlong into the third phase with very little experience to draw upon.

*These ongoing experiments included the University of the South Pacific, which is still using ATS-1 to link its 10 sites at campuses and extension centers, and Canadian Inuit who had begun northern native television and teleconferencing on ANIK-B, and have since established the Inuit Broadcasting Corporation.

Using hindsight, we can attempt to identify factors which separated apparently "successful" projects which made the transition from experiments to operational services, and unsuccessful projects which terminated at the experimental/demonstration phase. Among the apparently successful, we can list:

-- the Appalachian Community Service Network (ACSN), now providing adult education programs nationwide as "ACSN -- The Learning Channel." "This operation is an outgrowth of experiments by the Appalachian Regional Commission on the ATS-6 and CTS satellites.

-- Alaskan rural services: Learn/Alaska, the Legislative Information System, and the Public Health Service (PHS) dedicated audio conferencing network. The PHS was the first organization to invest in satellite facilities based on results of experimentation (on ATS-1).

In Canada, two graduates of the ANIK-B program are beginning to provide operational services:

-- The Knowledge Network, delivering adult education programs to cable systems and community colleges in British Columbia; and

-- Inuit Broadcasting Corporation, producing native language programs to be distributed using Canadian Broadcasting Corporation (CBC) facilities in the far north.

Yet to these tentative examples (none has yet demonstrated long term viability), can be added many more experiments in North America that did not succeed including applications for telemedicine in the U.S. and Canada, continuing education, in-school programming, and teleconferencing.

What lessons can be learned from these North American experiences and from developing country experiences to date, that will help to predict the actual developmental benefits that will be derived from satellites serving developing countries?

4. An Analytical Framework

In order to understand why the promise of communication satellites seems to have been delayed if not denied, it is necessary to consider a number of factors which encompass both the application and its institutional, economic, and political context:

Application Factors

-- analysis at the project or activity level: e.g. evaluation of a pilot project or experiment; prediction of the probable outcome of a project or experiment based on proposed goals, techniques, materials, etc.

-- analysis of project assumptions concerning available funding, cost of telecommunications links, follow-on support, etc.;

Development Sector Institutional Factors:

-- analysis of institutional factors related to the project sector; for example, sector structure, sector administrative strength, resources in terms of personnel and facilities, other demands on personnel and budget;

-- relationship of project goals to sector goals;

Economic Factors

-- economic status of the country or region (GNP per capita, economic viability of major productive sectors, balance of payments, etc.);

-- financial status of the development sector: level of ministry funding; adequacy of funding for existing activities;

-- economic viability of the development sector (for income producing sectors such as agriculture, fisheries mining, manufacturing, etc.);

-- economic expectations for the satellite system (profit projections, time frame to achieve profitability, assumptions about rates and services);

Telecommunications Sector Factors

-- structure of the telecommunications industry. (government or privately run, competitive or monopolistic, revenue retention policies);

-- relationship of satellite system to terrestrial systems;

-- tariff policies (full cost recovery, internal cross-subsidization, government subsidization, etc.).

Organizational Factors

-- analysis of the organization(s) responsible for satellite applications in relationship to the major institutions: as activities located within existing operational units, as special project unit of existing ministries, or as new special agencies;

-- a similar analysis for the satellite system management: e.g. within the telecommunications ministry, within the space ministry, in a special new or hybrid ministry or agency;

Political Factors

-- motivations for acquiring a satellite system;

-- political intervention in choice of sites, services, allocation of resources for projects and programs, etc.

5. Applying the Framework

The following sections will examine the significance of these factors. To a communication researcher, only the first set of factors may seem relevant. The evaluation of communications projects and experiments, including those using satellites, has traditionally been limited to a micro-analysis of the application -- i.e. did the project achieve its objectives? At the most basic level an evaluator may look for simple indicators of the actual functioning of the project: How many contacts were there between health aides and physicians? number of tutorials of distant students? number of requests for agricultural information? These are usually accompanied by attitudinal indicators concerning how the value of the project to the participants, their likes and dislikes about

various aspects of the project, their views on whether the project should be continued or expanded.

Similarly, data are often collected about the technical functioning of a project: e.g. equipment reliability and breakdowns, adequacy of equipment performance for project activities (sound quality, picture resolution, color quality, data transmission speed, etc.)

Clearly, this type of evaluation is a critical step in project assessment; a project which does not accomplish its own objectives (or cannot be modified through feedback from formative evaluation to do so) should not be continued or expanded. Yet during the experimental era outlined above, many projects were rigorously and positively evaluated, but were not continued after the experimental period or after the initial source of funding was withdrawn.

An additional set of criteria introduced into evaluations has been cost effectiveness. Researchers have looked beyond the internal project objectives to determine whether the approach of using satellite technology is justified in the achievement of the objectives. Do the benefits obtained justify the costs (in savings of time or travel, extension of service to new students of communities, improved productivity, etc.)? This type of analysis introduces an important economic element into the evaluation, assuming that it is based on realistic assumptions.

One of the problems of the early experiments was that satellite time was free. While many experiments might never have taken place without free time, the result was to obscure the value of the satellite transmission time, so that experimenters were not forced to consider how much they would have been willing to pay for the telecommunications, based on perceived benefits. Projects such as the Veterans Administration continuing education and consultation applications on ATS-6 and CTS and the PEACESAT conferences in the Pacific on

ATS-1 failed to consider how their activity might generate funding to cover the costs of commercial transmissions.

A related question is the extent to which there is an incentive to adopt the technological innovation demonstrated by the project. Perhaps the most dramatic examples of this "blindspot" come from education and health services. In the early 1970's studies sponsored by UNESCO proposed an educational satellite system for Latin America that would transmit programs to schools throughout the region. While technically feasible, the proposal was rejected on administrative and political grounds. Nations wanted to preserve the autonomy of their education systems. The administrative and political cost of coordinating curricula was too great to justify the potential benefits of improved instructional quality and standardization.

Similar North American examples could be cited. While an "Open University" with courses delivered by satellite has been proposed, the institutional structure of higher education and the competition for students and their tuition fees make an autonomous credit granting tele-university untimely, although quite technically feasible. In health services, numerous projects in "telemedicine" were funded during the 1970's, using both satellites and other technologies such as coaxial cable and telephone lines to deliver medical services via telecommunications. Although many of them were positively evaluated, almost none continued beyond their experimental funding period.

Rockoff (1977) points to the institutional factors in American medicine which acted as strong disincentives to such technological innovations. Rockoff suggests that an important question to ask in ascertaining why more telemedical projects had not become operational services is: "Who pays and who profits?" There will be little incentive in using communication technology to reduce referrals from nurse-practitioners to physicians if the physicians work in a fee-for-service practice. "Thus, a fee-for-service health system has no

incentive to adopt referral reducing (and hence cost-reducing) schemes." Rockoff also concludes that person-to-person video technology has not found a strong private sector market in health because "within a subsystem, such as a group practice or a hospital, it is neither a revenue producer ... nor a cost-reducer .... Therefore, there are no direct financial incentives for these subsystems to participate." (Rockoff, 1977)

Economic development projects (e.g. in agriculture) require an examination of the economic viability of the sector and its structure. For example, information of techniques to improve crop yields will not likely be highly valued if there is little incentive to increase crop yield because of low prices. Access to market information will be of little value if there is only one buyer in the area. Information about new techniques and inputs will have little value if the inputs (fertilizer, pesticides, etc.) are not available, or if the credit a farmer requires to purchase them is not obtainable. Similarly, the value of using telecommunications to coordinate shipping of crops to market will be limited if the transportation sector has insufficient equipment or fuel to function adequately. (Hudson, 1981)

Yet sector factors alone may not be sufficient to understand to what extent developmental benefits are likely to be derived from communications projects.

While the advent of communication satellites has been viewed as an important opportunity for stimulating competition in the United States, in many other parts of the world satellites have become instead the latest communications monopoly. For the user, this means there may be very little leverage in negotiating terms of access to the satellite system: e.g. price and terms of transponder lease, sublease of partial transponders, ownership vs. leasing of uplinks and downlinks, etc.

Melody (1979) states: "The history of satellites is one of wasted

technological potential and outrageous economic inefficiency in order to preserve the near monopoly market dominance of the established communications carriers." Price structures under monopoly conditions behave differently from prices under competition, when prices are lowered to stimulate demand. In Canada, Telesat was established under the Telesat Canada Act which stated that the corporation was to be owned one-third by the government, one-third by the telecommunications carriers, and one-third by the public through the sale of shares. Carrier domination has ensured that there will not be competition with their terrestrial transmission systems. Public shares have never been offered, on the grounds that the corporation was not yet sufficiently economically viable. Yet domination by the carriers and lack of public involvement have remove much of the incentive for Telesat to turn a profit by pricing competitively. As a result, many of the experimenters on the early CTS and ANIK-B satellites could not afford to pay commercial rates. A native communications organization which had successfully demonstrated the feasibility of a native satellite radio network on CTS was stymied by a Bell Canada tariff which charged different rates for satellite and terrestrial links in their regions, and required them to pay to haul their signal 800 miles to the Telesat uplink near Toronto.

Economic rather than technical factors also explain why rate structures for satellite services have not reflected the advantages of the technology. One of the technical advantages of satellites is that there is virtually no difference in the cost of communication between any two points, as all communication goes from one site 22,300 miles to the satellite and back to the reception site. Thus rate structures could be developed without reference to distance to reflect policy goals of social equity and to encourage citizens to stay in remote areas or to migrate to these areas. Yet we find that rate structures for satellite services generally are based on terrestrial point-to-point mileage.

Hard-won exceptions to this general rule are some teleconferencing tariffs which are not based on point-to-point mileage. In Alaska, the Public Health Service (PHS) leases an audio teleconferencing network linking regional hospitals with village clinics. The tariff for the service is based on the percentage of traffic this system represents at the various sites. Thus it is not mileage based, although it is based on other questionable assumptions, and at $875 per month per village and $160 per hospital it has come close to pricing telecommunications out of the range of the PHS (Hudson, 1981).

In the South Pacific, several years of negotiating were required to convince the carriers to file a tariff with INTELSAT for audio teleconferencing that was a significant departure from the carriers' initial tariff which simply summed the mileage-based charges for telephone calls to each point in the network. The difference to a 10 site user such as the University of the South Pacific could be as much as $620 per hour (Hudson, 1981).

Organizational factors at the satellite system level may also contribute to the probability of adoption of satellite projects. A technical innovation may be managed by an organization or ministry which does not have day-to-day responsibility for telecommunication services. As a strategy for carrying out research and development, the approach of establishing a separate organization may be the best choice; however, it can result in problems in transferring successful innovations to the operational sectors. In the U.S., the role of NASA was critical; without its space program there would have been no ATS series of satellites available for public service experimenters. However, those users had considerable difficulty in making the transition to the commercial environment of the telecommunications industry.

The role of space agencies has been influential in other countries. In India, for example, the Indian Space Research Organization (ISRO) had

responsibility for the SITE project -- not only for the operation of the satellite and provision of hardware in the villages, but also for software planning and evaluation. The result was a very innovative project, but there has been considerable difficulty in transferring the approach to the operational technical and utilization ministries, and in obtaining sufficient applications funding to carry the SITE experience through to the operational INSAT system. (Mody, 1979) Similarly, in Brazil, the Brazilian Space Institute (INPE) was responsible for planning for both the technical systems and educational applications in the SACI/EXERN project. (McAnany and Oliveira, 1980) The ministries of education and telecommunications were effectively excluded, and the INPE proposals were never implemented. Brazil's commercial satellite to be launched in 1985 will be managed by TELEBRAS, the telecommunications authority. It appears unlikely that the earlier efforts of INPE will be used in planning the operational rural services.

Finally, political factors may need to be considered. Since satellites are such a capital intensive and visible technology, a government which invests in the technology is likely to have its own goals for the benefits it wishes to derive from the system, which may be at variance with developmental benefits. In Indonesia, PALAPA A was an "off the shelf" model similar to the ANIK A and WESTAR series because the system had to be launched before the 1976 presidential election. In Canada, although much public attention was focused on the goal of providing communication services to the remote north, the Telesat system was established primarily to get Canada into the space industry and to secure desirable orbital positions. A similar pattern appears to be being repeated in Australia where services to the outback have been emphasized while commercial entities maneuver to dominate the system. In India, the goal of introducing color television (through importation of sets and kits) appears to have over-

shadowed the goal of developing appropriate indigenous technology. (Chawla, 1982).

6. The Technological Imperative

With the exception of India, all developing countries now using or planning to use satellites will have skipped an in-country experimental phase*. It could be argued that they might substitute to some extent for this lack of experience by drawing on the experience of other projects. Projects undertaken in remote parts of North America could provide at least some useful information for other projects planned for isolated regions, just as applications for various sectors such as health services, education, or agriculture should have at least some transferability. Yet it appears that these lessons are not widely shared or understood, despite efforts to disseminate the project results.**

Similarly, it would appear that many countries have a wealth of experience that could be applied in planning satellite projects. However, the glitter of the technology often seems to obscure the fact that it is simply a means of providing broadcasting and telecommunications services, rather than a totally new medium. For example, in Australia, I was told by Australian educators that they knew nothing about satellites, which might have been literally true, but ignored the fact that they had been using two-way radio for distance education ("The School of the Air") for decades. Similarly, in the early days of the Alaskan projects, southern planners sometimes expressed concern about how native villagers would react to satellite technology. The health aides themselves had no such hesitation. They had used two-way radios for years. To them, the satellite just took the place of the unreliable HF radios. When the same

* Some countries, such as Peru and Indonesia, are conducting pilot projects in rural applications, but as part of an operational satellite program.

** An exception may be the efforts of Australian aborigines to learn about satellite projects by Indians and Inuit in North America, in planning for AUSSAT applications.

satellite began to deliver television to the villages, many villagers saw it as simply an improvement over the videotape service they had arranged from Seattle.

At a more abstract level, these could be seen as examples of the technological imperative which tends to drive planners to focus on the technology rather than on the applications. Yet many countries have very relevant experience which could be applied to satellite planning. There are numerous examples of applications of radio for teaching literacy, nutrition and health education, and agricultural extension. Similarly, television has been used for formal education and community development. Two-way radio systems have linked health aides to physicians and project managers to headquarters. (Communication Project Profiles, 1981) All of these experiences can be used in planning development projects using satellites.

7. Toward Realizing the Potential

As outlined earlier in this paper, we are now in the operational era of satellite communications, in developing as well as industrialized countries. We are not likely to have the luxury of experimentation in the future, as more countries invest in satellite technology to meet their domestic needs, either through leasing INTELSAT capacity, participating in regional systems, or procuring their own domestic satellite systems. Yet, in a sense, the result is that the experiment continues, but the stakes are much higher. The investment in satellites will only be justified in terms of national development if it contributes to the developmental goals of the country. While generation of surplus revenues could be argued to meet this goal by providing funds that can be applied to other developmental activities, direct returns alone do not represent the full potential benefits of the system. It is only through the indirect benefits of the telecommunications network that the full potential of

this technology for development will be realized (cf. Hudson, Hardy, and Parker, 1982).

By the end of the decade, communication researchers will be in a better position to determine whether the developmental potential of communications satellites has been realized or indeed can be realized. But rather than waiting in the wings to present the verdict, researchers can assist planners in applying the lessons we have learned from experiences with satellites to date and from the introduction of other communications innovations, to help tilt the balance toward achieving their developmental promise.

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